President Griswold; Gentlemen of Yale --

I suppose it might be said that on this panel I represent the pragmatists -- that element of our national activity concerned with the nuts and bolts of progress as we translate the findings of science into the goods and services required by our modern society. In a crude sort of way, that statement might have been taken as a description of the work of the majority of those persons concerned with technological advance just a few years ago. Certainly it would have been a proper description of the task of the engineer when I graduated from Sheff 33 years ago. But for today's scene, this is much too narrow a concept. It is to this point that much of what I say this afternoon will be

addressed.

Quite naturally, my remarks will be cast in the framework of the business in which I am engaged. I say "quite naturally" because I have little time to think of anything else these days. More importantly, however, it seems to me that the space business provides an excellent example of the complex interweaving of the scientific, technological, political and social elements of our society that is part and parcel of our national activity today.

I propose to relate for you something of the scope and purpose of the nation's program for the exploration and exploitation of outer space; to point up some of the problems posed by our active involvement in this

exciting and complex business;
to raise some of the questions that
should be answered positively --
not just by default; and to relate
all of these matters to the central theme
of this convocation -- our concern
with and for higher education in the
United States and, more specifically,
with the Arts and Sciences, here at
Yale.

Although man has looked to the
stars for his inspiration throughout
recorded history, it took the shock
of Soviet accomplishment to set in
motion in this country a wide-ranging
program of research and development
by means of which it is hoped that
we may gain greater understanding
of the cosmos and discover, perhaps,
something of the origin of the
universe -- even of life itself.

The dimensions of that program have been reported many times but are little understood. The welter of words flowing from the pens of our own public information people, the imaginative but sometimes misleading or less-than-objective statements that appear in magazines and newspapers, as well as public pronouncements out of Washington that may tend to be obscure to those not in touch with the day-to-day happenings in Congress and the Executive Branch, must make it difficult, if not impossible, for the average, so-called informed citizen to understand just what is going on and how important it is that large sums of money be devoted to a program of this kind.

Very briefly stated, the nation's program for the exploration of outer space for peaceful purposes for the benefit of all mankind -- to paraphrase the policy statement in the Space Act of 1958 -- is already an impressive activity. Its dimensions, quite aside from the activities of the Department of Defense in space, may be stated in terms of men, facilities, money and program.

The National Aeronautics and Space Administration has been in business for two years -- two years and seven days, to be exact about it. On its payroll one finds some 19,000 people, representing almost every field of professional activity, except that of the clergy.

Spread throughout the nation, in six major research centers and three modestly large field stations, these people will spend or manage the spending of more than $900,000,000 in the current fiscal year. Unless there is a drastic change in the nature of the program -- or in the nature of the Soviet competition or in the will of the people as expressed by their representatives in the Congress -- it is probable that the annual expenditure for our nonmilitary space program will reach and may exceed $2 billion before the end of this decade.

An unhappy interruption in the preparation of this paper occurred at this point. It was Sunday, the 25th of September,

and I was diligently at work writing these lines when at 11:45 in the morning my assistant called to say that our Atlas Able V launch attempt had failed. This, you may recall, was our second effort to place a 385-pound, highly instrumented, payload package into an elliptical orbit around the moon. To put this in perspective with one of the purposes of this convocation -- a matter about which I am not supposed to speak, by the way -- this lunar orbitting project has cost this nation more than $20 million thus far -- almost one third the amount needed by Yale to enable her to more adequately meet the need for quality and excellence in leadership for this nation. And all we have left from Atlas Able V is some miles of telemetry tapes and a renewed determination to

succeed in the next attempt.

Now back to the discussion at hand -- the program we are carrying out is intended to satisfy a number of objectives as stated in the Space Act of 1958. Among these we find

--the expansion of human knowledge of phenomena in the atmosphere and space;

--the preservation of the role of the United States as a leader in this field and in the application of this new technology to the conduct of peaceful activities;

--the establishment of long-range studies of the potential benefits to be gained from such peaceful

activities utilizing the space environment; and

--cooperation by the United States with other nations in this work and in the peaceful applications thereof.

The major elements of the broadly based and wide-ranging program we have under way can be divided into three categories -- scientific investigations in space, including the exploration of the moon and the nearby planets; the development of useful applications of the phenomenology of outer space in fields such as in meteorology and communications; and the flight through outer space of manned vehicles for research and exploratory purposes.

Underlying these program elements are the development of spacecraft carrying instrumentation and other apparatus required to accomplish the desired mission objective; the engineering development and production of rocket-powered launch vehicle systems that are needed to propel unmanned and manned spacecraft into orbit or deep space; and the provision of tracking and data acquisition stations necessary to evaluate the immediate success of the launch and to acquire and reduce for analysis the millions of bits of information about the phenomena we are investigating.

The search for new knowledge through investigation of the space environment involves most of the important scientific and engineering disciplines as well as many of the professions. The astronomer eagerly awaits an opportunity to mount his telescopes on platforms above the earth's atmosphere, confident that new worlds await him as his ability to penetrate the distant reaches of the galaxies are thus enchanced. The physicist and the chemist will conduct experiments intended to probe into the earth-sun relationship and to open new avenues in the study of the origin of the earth and our solar system. The life scientist is excited about the possibilities

of discovering forms of extra-terrestrial life and of deepening his understandings of the origin and nature of the life process. The mathematician, the metallurgist, the lawyer, the medical man, the political scientist -- indeed, almost every category of specialized talent -- finds in this program a new and exciting challenge to his creative instincts and natural curiosity.

That there will be tangible benefits for mankind from our space program appears certain. In the field of weather forecasting, the success of our first, relatively crude, experimental meteorological satellite, Tiros I, in observing and recording, from a vantage point 400 miles above the earth's surface,

the phenomenology of weather formation, suggests that improved weather forecasting techniques will be possible. Longer range and somewhat more accurate forecasts of weather conditions in almost any part of the earth on a timely basis could result in very substantial benefits to mankind.

Similarly, the probability of successful and economically feasible use of satellite-based mechanisms for the transmission of various types of communications over long distances is sufficiently encouraging as to cause one and perhaps more of the nation's great communications organizations to undertake a substantial expenditure from its own corporate funds for the development of such a system.

That there will be other useful applications in such fields as navigation and mapping seems assured. And there will be, of course, valuable by-products of space research and development in a variety of industrial processes too numerous to mention.

With respect to the flight of man into and through space, we find a wide divergence of opinion. Some call it a stunt undertaken largely to beat the Soviet Union to a spectacular first in the field. Others caution against the overlarge commitment of funds to such a project in comparison with other urgent and justifiable demands for funds. But the

advocates of manned space flight
are devotees of the slogan of our
fellow Yale alumnus, Phil Pillsbury,
-- eventually, why not now?
Certain it is that we have much to
learn that can be learned through
the use of instrumentation --
an art in which this nation excels.
But no one has devised an instrument
capable of exercising judgment,
of dealing with the unexpected,
and of interpreting strange and
seemingly unrelated phenomena.
We can instrument for what we
expect to find, but the unexpected
usually is the most interesting.
For these and many other reasons,
while the pace may change, I
suspect that we will continue to
move forward in our attempt to
enable man to fly where he will
at times of his own choosing.

Most people probably view this space program as one which involves, principally, the efforts of scientists and engineers. Indeed, this is the case. And they have many and difficult problems to solve. Happily, most of these problems can be identified and stated in a manner that indicates, at the very least, the direction to be taken in solving them. But the larger and, to me, more important problems we face in this as in other [redacted] fields do not fit into that comfortable pattern. Let me try to explain that statement.

I have now been on my current assignment for 25 months. For the first few months of that term, as we were putting together the elements of our initial program,

we were struggling with the question -- what is it we are trying to accomplish in this program? Accepting the competitive situation with the Soviet Union, touched off by their launching of Sputnik I, as the prime reason for mounting a major program of space exploration, was that enough to guide all of our planning?

It was clear to the scientists involved, of course, that we were to be engaged heavily in a new dimension of the search for a better understanding of the physical world. A new window had been opened on the obscured vista of the space that surrounds us. Just as men continued their efforts to climb Mr. Everest because it was there to be climbed, men have sought knowledge of the unknown as a natural extension of their knowledge of the universe of which we are such a small part. But this consideration, which in the long run must certainly be the most important

motivating force, seemed to play a very minor role in the generation of the pressures for speed and progress we were feeling in those early days. While driving ahead with vigor and determination, then, some of us were seeking an additional and perhaps more fundamental rationale for the sense of urgency with which we were attacking our problems.

It was for this reason that I was not willing to accept competition with the Soviet Union as the only loom on which we were to weave the fabric of new knowledge we were seeking for the benefit of mankind. It is a fact of life, however, that governmentally supported research and development programs of the magnitude and type of the space program are not conducted in a political vacuum, from either a domestic or international point of view. And so, I have accepted this aspect of the situation --

competition -- as the principal factor which determines the pace at which we pursue our goals in the space business. But if we agree that international competition is important as a pacing element -- as I do -- do we know for what we are competing? Is it the respect and affection of the so-called underdeveloped nations? Is it the smug satisfaction of being first again in a technology which we thought belonged to us? Is it the fear of annihilation by a nation grown confident in its strength as defined by its propaganda-extended accomplishments in a visible and exploitable field of science and technology? Or is it the satisfaction of a personal and a national desire to be leaders in any effort to improve the lot of mankind through the acquisition and dissemination of knowledge?

Whatever the reasoning employed may be,

it is clear to me that, as of the present, the enhancement of national prestige in a divided world has been and continues to be uppermost in the minds of the majority of people who have bothered to think about the matter of competition in the space arena. And this principally because of the fear that the loss of national prestige that we have experienced for a time somehow upsets our equanimity and probably means, in some vague way, that we are second-best in <u>everything</u>.

As I look back upon these two years of involvement in this exciting activity, I find myself wishing that we could have been operating in support of more clearly understood and nationally accepted goals or purposes. To hang the generous support of scientific inquiry <u>solely</u> on the peg of competition with the Russians is an unsatisfactory, long-run solution to our need for general understanding of the importance of free inquiry in science and

in other fields as a basic underpinning for a democracy such as ours. To realize that the present concern with the adequacy and quality of our educational system has a large portion of its root system in that same competition, is again an evidence of a lack of self-generated national purpose.

Gentlemen, how can we decide how important it is to spend, on an urgent basis, the very large sums of money required to put a man into orbit or to explore the atmosphere and surface of Mars or Venus unless we have a pretty firm grasp of what the purpose behind the whole space effort really is? And yet, who knows the answers to this and many similar questions today? Who is thinking about them and doing something about developing some answers? We have grown up in a world where we could afford to move along without too clear an idea of the whys and the wherefors. Modern science and technology, with the formidable competitor we have in the generation and use of this technology -- a competitor intent

on discrediting our way of life as he moves toward his goal of winning the competition -- has changed this, at least in terms of degree and urgency.

Where do we get answers to such questions? Where on the public scene do we look for people to aid in the thoughtful structuring and re-structuring of our immediate and longer range activities to fulfill the purposes that Americans hold dear -- whether or not they are always able clearly to enunciate them in deathless prose? It seems obvious to me that our centers of higher education constitute the focal point of leadership for defining our national purposes and for training the men and women who

will be dedicated to the accomplishment of those purposes.

Never was there a time of greater need for good people of specialized talent, soundly grounded in the precepts that have stood the test of time and adversity in this nation as in no other nation in history. Surely, this is the day of the scientist and the engineer. But it is no less the day of the economist, the lawyer, the teacher, the political scientist, the historian, and the philosopher. And in every case, the education offered to the young men who deserve an opportunity, and will work to gain one, must be grounded on solid foundations of scholarship and truth but must also recognize

the urgency of the great specific problems of our times. As a fellow educator and an engineer, I am delighted to see the steps being taken by President Griswold and a committee of the University to modernize and strengthen the College of Engineering at Yale. There is no room for the mediocre in seeking solutions to our problems through the actions of educated men whether it be in engineering, in science or in any other field.

It is in an all-out effort to meet these challenges that we find Yale now engaged. As is so well stated in the booklet entitled, "For the Arts and Sciences at Yale"--

"The arts and sciences are the vital center of Yale.

They are the fundamental subjects and disciplines -- the humanities, the natural sciences, and the social sciences -- of which the academic curriculum is composed, the backbone of secondary and higher education, the foundations of higher learning, and the professions. As Colonial America, and after it, the Young Republic, once stood to gain by the degree to which these subjects communicated their benefits to society through its clergy and lawyers, so today as a world power the United States stands to gain (or lose) by the degree to which they transmit their

benefits to all citizens capable of assimilating and putting them to work in its numerous affairs."

Gentlemen, I hope I have been able to show you, in the context of the technologically based program in which I am currently immersed, some of the broader problems that exist for our Government and for our citizens. It is not disheartening to me that we do not have all the answers to these important questions. It merely renews my faith and vigor in championing the need for better trained, more dedicated minds.